better discernment of angles compared to the DCT; however, it has problems with boundary conditions. The Hademard Transform has certain computational simplicities.

Turning now to FIG. **11**, the visible image portion **1102** is processed in block **1110** by a DCT to produce a visible transformed block **1112**. In the preferred embodiment, the image portion **1102** is assumed to consist of 8×8 pixels, and therefore the transform contains 8×8 elements. This is a common size used in many compression algorithms, and is found to work well. It is used in this illustration for convenience, and not by way of limitation. In the DCT, by convention the lowest frequency element is at the top left **1114**. This element contains the DC (Direct Current), which is the average of all pixels in the image block **1102**. This inherent separation of this low frequency term means that explicit frequency division is not needed in the DCT transform space. Similarly, the infrared image portion **1116** and defect scratch **1118** are processed by a DCT **1120** to produce an infrared transformed block **1122**.

Moving to the right from the DC term **1114** are the spectral components **1124** of the vertical strands of hair **1104**. Moving down from the DC term **1114** are the spectral components **1126** of the scratch **1106**. This simple illustration spotlights the power of a transformer to isolate a defect from image detail by segregating specific details both by frequency and by angle. By operating in transform space, the bounded subtractor **1128** is able to completely subtract out the defect component **1122** between the upper and lower bound functions **1130** and **1132** which produce corrected images **1134** and **1136** without touching the desired image components **1124** at image **1138**. After taking the inverse DCT at **1140**, the strands of hair **1142** are correctly reproduced with no gaps and no defects. In effect, the image has been smudged along the lines of the image so the smudging is almost unnoticed.

As was mentioned, the preferred embodiment uses a block size of 8×8. A smaller block size will give better discernment based on position but poorer discernment based on frequency and angle, while a larger block will give opposite results. The block size of 8×8 has been found to be an optimum compromise but is not offered as a limitation.

FIG. **12** further describes the details of operation in a transform space. An input visible image **1202** is broken into many blocks, which may be divided into 8×8 pixels as illustrated. These blocks may overlap to reduce boundary effects. A specific block **1204** is selected for correction. The logarithm of each pixel in the block is taken, and the DCT performed on the block to produce the transformed block **1210**, as described earlier.

A defect which may occur in some scanners is misregistration of the infrared and visible images. The effects of this can be compensated as is now shown. The infrared image **1220** is also divided into multiple blocks, and the corresponding block **1222** is selected, but a wider area **1224** around the block is utilized. An example would be a 10×10 region. After taking the logarithm of each pixel in the region, several 8×8 regions are selected from this larger 10×10 region. For example, a center region **1226** may be taken, an upper region **1228** shown by the dotted line, a lower region, a left region, and a right region. The DCT is taken on each of these selected regions.

Each of the regions just mentioned produces a suite **1230** of DCT blocks. The perfect correction may be at a fractional pixel of displacement; therefore, none may match exactly, but a subset of these DCT values will give a good estimate. In the illustration, each infrared DCT in the suite **1230** of DCTs is compared with the visible DCT **1210** to test the degree of match using the suite of function blocks **1232**. In one embodiment, the three with the best match are used to determine the upper and lower bounds. In another implementation, each is factored in with a weighted average based on the exactness of the match. In any case, this suite **1230** of DCTs is used by function block **1233** to generate an upper and lower bounds **1234** and **1236** for each element of the DCT block, and these bounds used by the bounded subtractor **1238** to generate the corrected DCT block **1240**. After taking the inverse DCT to generate block **1242**, and the inverse logarithm, the corrected image block **1248** is placed in the output corrected image **1250**.

FIG. **13** teaches how the suite of function blocks **1232** of FIG. **12** may take the correlation. A classic mathematical correlation takes the sum of the products of all terms of the two blocks being correlated. However, in the case of this invention, the visible record may contain very large values induced by image details at lower frequencies, not echoed in the infrared record, that could overpower valid defect details at higher frequencies. FIG. **13** teaches a method of weighting each element with a magnitude corresponding only to the infrared component, which bears the defect detail that will appear in both the infrared and visible images. The multiplication uses only the sign of the visible element with the value for the corresponding defect element. This prevents a huge magnitude of the visible element from overpowering other terms. In an alternate embodiment, the visible and infrared terms are multiplied similar to a classic correlation; however, the visible term is limited in magnitude to be less than or equal to the infrared term magnitude.

Referring again to FIG. **13**, an image block is obtained at step **1300**. For each block, at step **1302**, the 8×8 elements of the DCT visible block are received. At step **1304**, the 8×8 elements of the DCT defect block are received. The correlation is initially set to zero at block **1306**. For each of the 8×8 elements, a new correlation value is calculated at step **1308**. The new correlation is equal to the previous value for the correlation plus the sign of the visible element multiplied by the corresponding defect element. The correlation for each block is output at step **1312**. If any blocks remain at Step **1314**, a new block is obtained at step **1300**. If not, the calculation is completed.

FIG. **14** illustrates graphically a way of calculating the upper and lower bounds. In this figure, only one-dimensional signals are shown for simplicity. These may represent a single row **1402** (FIG. **14***a*) of a DCT block **1404**. The end of this row closest to the DC term **1406** would represent lower frequencies, and the other end would represent higher frequencies. In two-dimensional space, the distance from the DC term **1406** to any specific element would measure the frequency of that element.

As discussed before, the three displaced infrared DCT transforms **1410**, **1412**, and **1414** (FIG. **14***b*) with the highest correlations to the visible DCT transform may be received. The range of these three transforms may give an upper and lower bound **1420** and **1422** (FIG. **14***c*) for each element along the row of the DCT. The DC term may be handled as a special case wherein the upper and lower bounds are set the same, and equal to the average of the DC term of the three blocks. Thus, the DC term is excluded from processing by the bounded subtractor because the DC term represents average brightness and cannot be set toward zero as a default nulling.

The next step is to extend these bounds, recopied as dotted lines **1420** and **1422** (FIG. **14***d*) to wider bounds **1426** and